National Aeronautics and Space Administration

Rocket Report

2015

Sounding Rockets Program Office

What's inside...

In Brief...

The new Black Brant Mk 4 vehicle will fly for the first time in October 2015 from Wallops Island. The payload carries several technology test experiments and instruments.

Payload teams are preparing for the coming Norway campaign. Two rockets will be launched from Andoya with the launch window opening on November 27.

The Multiple User Suborbital Instrument Carrier (MUSIC) payload will be launched from Wallops Island in October on a Terrier-Improved Malemute rocket.

The sounding rockets program will celebrate 45-years at Wallops on November 30, 2015. More on page 7.

A very busy flight schedule is in progress. The Sounding Rockets Program has 11 missions on schedule during the period September through November. Three have been successfully completed and eight remain.

46.012 UO Koehler - RockSat-X was succesfully launched from Wallops Island on August 12, 2015.

Students from Hawaii with their experiment after the successful flight.

The 46.012 UO RockSat-X mission was launched from Wallops Island, VA on August 12, 2015. RockSat-X is the most advanced of three student flight programs managed by Colorado Space Grant Consortium and supported by NASA. RockSat-X provides participating University faculty and students an opportunity to build,

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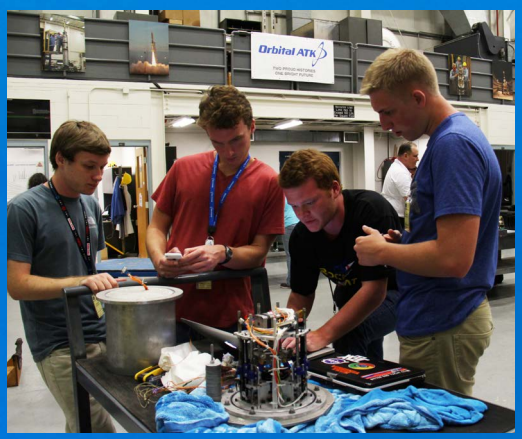
RockSat-X continued...

test and fly an experiment of their own design onboard a Terrier-Improved Malemute sounding rocket and includes full featured sounding rocket support systems, such as telemetry, attitude control and recovery.
Prior to their RockSat-X flight, participants have flown two less advanced types of experiments, RockOn and RockSat-C.

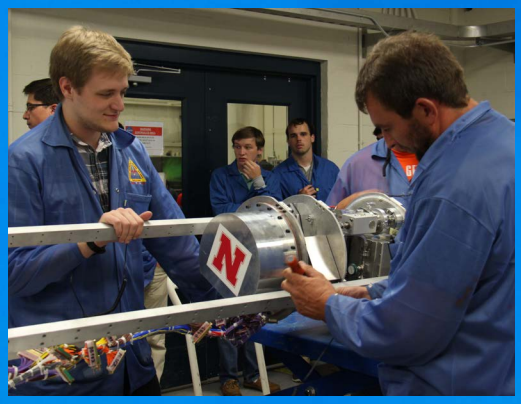
The following schools participated in the 2015 RockSat-X mission:

Capitol Technology University (CTU)
Project Hermes
The project goal was to test OSH-Comm (Onboard Satellite Hotspot Communications) System using TCP/IP Protocol by tapping into an existing network of communications satellites. The project uses Commercial Off the Shelf (COTS) components and the Iridium satellite network. A web-based interface is used to receive telemetry, send commands, see data transfer and monitor health and safety information Additionally, the experiment captured an image during the flight and sent it through the Iridium network.

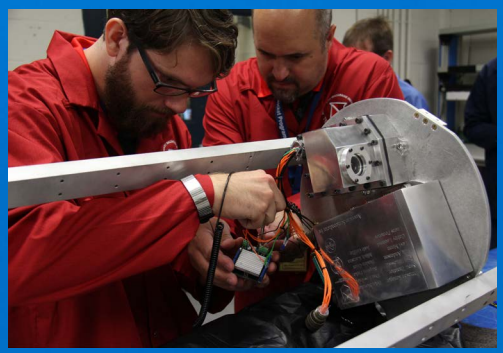
University Of Hawaii Community College System
Project Imua
The primary mission goal for Project Imua is to encourage UHCC students to explore and enter STEM-based careers by engaging in team-oriented, problem-solving activities that emphasize the integration process involved in the design, development, construction, testing and documentation of launch-ready CubeSats and scientific payloads. The science goal of the experiment was to make direct measurements of solar spectrum UV components without atmospheric absorption. Contribution of UV variation in the 200 to 400nm range to total solar irradiance is highly uncertain. Data will contribute to understanding of solar dynamics. The experiment collected one full spectral sweep (at 2ms integration time: 4.096 s/sweep) of data between 200-600 nm with 0.4 nm resolution.



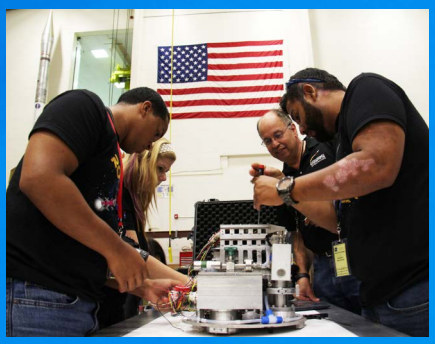
Virginia Tech (VT)
Virginia Tech students successfully completed a 3D print in the space environment and collected data on how to improve the shortcomings of the VT 3D printer design. This is a proof of concept mission for 3D printing in space and collects information on the effects of changing gravitational loads on 3D printing.



University of Nebraska Lincoln (UNL)
The experiment from the University of Nebraska Lincoln compared buoyant convection on the ground in the presence of gravity to the expected absence of buoyant convection in the microgravity environment. Additionally the experiment characterized crystal growth in microgravity through the study of buoyant convection in a supersaturated solution of Sodium Acetate Trihydrate (SAT).
The experiment provides more data on crystal formation in microgravity, specifically addressing the question why crystals grown in space are larger and purer than ones formed on the ground.
Video cameras recorded the reactions. A thermal tracer was used to visualize buoyant effects during crystallization. The crystallization reaction began via a seed crystal planted into a sodium acetate trihydrate (SAT) solution by a linear actuator. A thermal tracer was used to visualize buoyant effects during crystallization.



Northwest Nazarene University (NNU)
Experiments from Northwest Nazarene University were designed to demonstrate the usefulness of flexible electronics when applied to data collection and storage in space-flight applications.

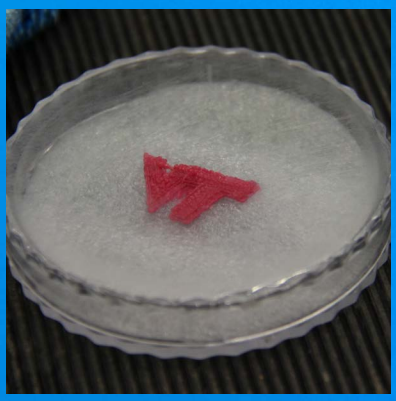


University of Puerto Rico (UPR)
The University of Puerto Rico experiment attempted to collect micrometeorites using two deployed collection panels. The collection panels are sealed to withstand re-entry conditions and final astrogenomic analysis to be conducted in a lab setting. Additionally, the experiment's impact detection system served as a collector for organic materials, which will be analyzed using Next Generation Genomics in order to study the possible origins of life as stated in the Panspermia Theory. Ultra high definition video was recorded looking outwards from the aft end of the experiment section where micrometeorites were to be collected from.

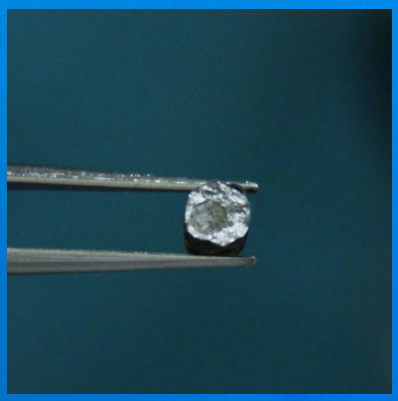
University of Colorado - Boulder
X-HD Experiment Deck
The X-HD Experiment Deck recorded HD video of the flight and all experiments providing a flight demonstration of new experiment hardware for use on RockOn, RockSat-C/-X. The deck includes eight GoPro cameras, four of which are deployed and retracted on a track system for viewing down the length of the experiment section and four are stationary and pointed perpendicular to the thrust vector.

In addition to the X-HED experiment Univeristy of Colorado students flew an experiment to generate a sample of an immiscible alloy composed of 80% Aluminum and 20% Indium by mass while in microgravity. The powdered aluminum indium mixture was melted via induction heating and the sample created in microgravity will be compared to ground samples after the flight. This experiment Investigates the effect of solidification in microgravity on the microstructure.

Early results, imaged below, from the Virginia Tech and Colorado University experiments were available immediately on payload return to Wallops. Complete analysis is still in progress.



Virginia Tech logo printed in space during the flight of 46.012.



Alloy created during the RockSat–X flight onboard the experiment from University of Colo–rado Boulder.

For more information about RockSat-X, visit: http://spacegrant.colorado.edu/national-programs/rs-x-2015-home

Images by Berit Bland

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36.282 US Kankelborg - Multi-Order Solar EUV Spectrograph (MOSES) 2 launched successfully on August 27, 2015.

MOSES-2 investigated the transition region of the sun using an imaging spectrograph and the Hα guide telescope. MOSES takes measurements in the extreme UV part of the spectrum and this mission focused on obtaining line intensity images for Ciii 459.3A and Ne vii 465.2A at 1.2" resolution over a 20' X 10' field of view with reasonable cadence (approx. 45 s). Additionally the investigation set out to obtain simultaneous line width and doppler shifts for the Ne vii line.

MOSES payload integration at White Sands.

For more information on the MOSES mission, see: http://www.nasa.gov/feature/goddard/nasa-funded-moses-2-sounding-rocket-to-investigate-coronal-heating

36.291US Winebarger - Chromospheric Lyman-Alpha Spectro-Polarimeter (CLASP) launched successfully on September 3, 2015.

The Science goals of CLASP were:

- detection of atomic polarization of the Lyman-alpha line from the solar chromosphere.
- detection of the Hanle effect polarization.

CLASP in a clean room at Marshall Space Flight Center.

The aim of the CLASP mission was to achieve the first measurement of magnetic field in the upper chromosphere and transition region of the Sun through the detection and measurement of Hanle effect polarization of the Lyman alpha line. The Hanle effect (i.e. the magnetic field induced modification of the linear polarization due to scattering processes in spectral lines) is believed to be a powerful tool for measuring the magnetic field in the upper chromosphere, as it is more sensitive to weaker magnetic fields than the Zeeman effect, and also sensitive to magnetic fields tangled at spatial scales too small to be resolved. The Lyman-alpha (121.567 nm) line has been chosen because it is a chromospheric/transition-region line, and because the Hanle effect polarization of the Lyman-alpha line is predicted to be sensitive to 10-250 Gauss, encompassing the range of interest.*

According to Dr. Winebarger initial results indicate that breakthrough science, detection of scattering polarization of Lyman-alpha, was accomplished by CLASP. Stable pointing of the payload was critical to achieve the science measurements.

"This is an achievement many of us have been anxiously waiting decades to see," says Dr. Moses/NASA HQ Program Executive.

* http://adsabs.harvard.edu/abs/2011AGUFM.P14C..05K

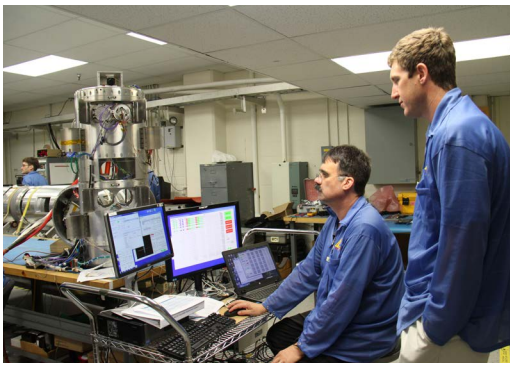
39.012 DR Bernhardt - Charged Aerosol Release Experiment (CARE) II launched successfully on September 16, 2015

The CARE II payload was launched from Andoya Rocket Range, Norway on September 16, 2015. The CARE II mission examined the effect of artificially-created, charged-particulate layers on the scatter of UHF, L-Band and S-Band radars. The artificial particles were created from 37 CRV7 C14 motors ignited in the ionosphere. CARE II studied the exhaust plume physics including Magnetohydrodynamic (MHD) waves and electric fields. The optical signature was measured from scattered sunlight and ion-molecule-electron reactions. This mission included a total of 44 rocket motors in one vehicle, a record for sounding rockets.

Integration and Testing

36.310 NT Hesh

The 36.310 NT mission is the first flight of the Black Brant Mk4 motor. To maximize utility of the test flight several technology development experiments are onboard and include: new updated ejection systems for sub-payloads, an experiment to evaluate materials for radiation and thermal heat shields is provided by Orbital ATK, NASA Langley's Advanced Near Net Shape Technology (ANNST) project is flying a payload skin section (ORSA adapter section) created using spin- and flow-forming manufacturing processes. Several NSROC technologies will also be flown. This mission is currently scheduled for launch from Wallops Island, Va on October 6, 2015



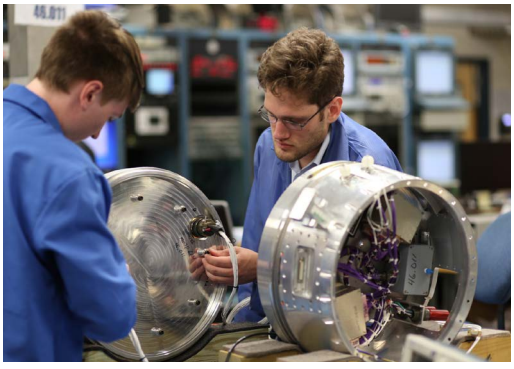
Brian and Ernie (ACS) are ready for pre–vibe sequence.

Walt and Andrew with a deployable sub–payload.

46.011 GP Milliner – Multiple User Suborbital Instrument Carrier (MUSIC)

MUSIC provides NASA Applied Engineering and Technology Directorate (AETD) personnel an opportunity to gain experience in developing sounding rocket technology, conduct systems engineering processes and Test NASA AETD experiments. This mission will result in a standard payload carrier with predefined mechanical, telemetry, power, and attitude control capabilities to be offer to reimbursable customers and other Wallops Flight Facility organizations. The payload carries experiments/instruments developed by AETD and include, High Data Rate X- Band, Wheel Tracker Experiment (WTE), Diminutive Assembly for Nanosatellite deploYables (DANY) TM Wet/Sealed Nosecone, Temperature and Strain measurement, Strain Gauge management System (SGMS) and Iridium GPS Beacon. Additional experiments from West Virginia University's Undergraduate Student Instrument Project (USIP) include instruments for Plasma Physics and Flight Dynamics with GPS and camera. These experiments will be flown in the wet section of the payload, i.e. the section is not sealed and will get wet when the payload impacts the ocean.

Scott, Matt and Henry working on MUSIC.



WVU students integrating their experiment.

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Image by Nate Wroblewski/NSROC

Sub–payload deployment testing.

MUSIC team with payload during integration.

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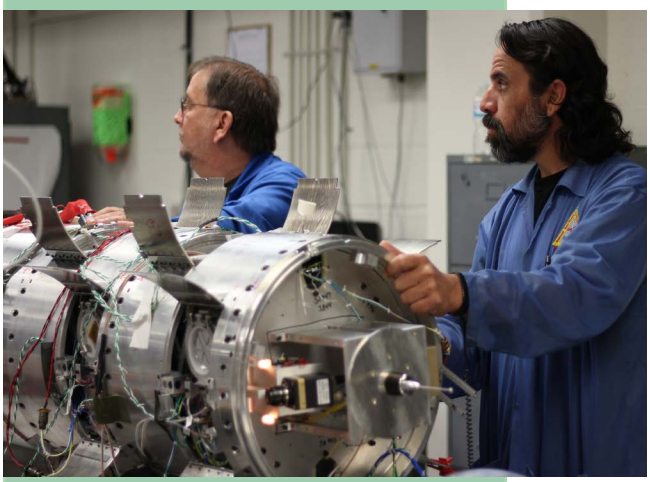
Picture Place

Charlie setting up for Hesh 36.310 sequence testing.

Chris, Joe and Dave collecting temperature data on RTV.



Dwight and Jorge sequence testing the Hesh payload.

Samuel setting up his machine to make rocket parts.

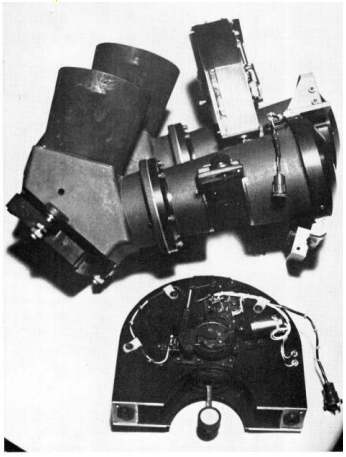
Walt inspecting 36.310 Hesh deployables.

ACS team Mike and Dan posing before RockSat–X sequence test.

All images by Berit Bland

November 30, 2015 marks 45 years of sounding rockets at Wallops.

On November 30, 1970 management of the sounding rockets program was transferred from Goddard Space Flight Center to the Wallops Flight Center (later Wallops Flight Facility). The first mission launched after the program relocation was a Princeton University astrophysics payload, 4.267, flown from White Sands Missile Range on December 2, 1970. Principal Investigator, Dr. D.C. Morton, had launched a series of rockets starting in 1964 and this was his 14th mission using the Aerobee 150 vehicle. The scientific purpose of the flight was to photograph far-ultraviolet spectra of stars in the constellation Perseus to study stellar absorption lines, circumstellar absorption and emission line and interstellar absorption lines.



Schmidt objective spectrograph

With the beginning of the space age rockets were quickly becoming mainstream vehicles to carry scientific payloads above the Earth's atmosphere. The Aerobee built by Aerojet was the second rocket* developed for the purpose of scientific measurements both within and outside of the atmosphere. The first version of the Aerobee was designed to carry a 68 kg payload to 60 km or above. The Aerobee 150 could carry approximately 100 kg to 200 km. At the end of the Aerobee program there were 10 versions of the vehicle.

In addition to launch vehicle development, the payload support systems also saw continued improvement during the early years of research flights. The first spectrophotometers were flown without attitude control systems in 1961 by NASA's Goddard Space Flight Center, Stecher 4.011, and were mounted normal to the rockets roll axis with a very limited "time on target". Development of a three-axis attitude control system by Space General Corporation (first science flight in 1966 by Morton and Spitzer) made it possible to point the instrument toward a specific target for longer periods. The Space General system could point the instrument within 3 degrees of the scientific target with a limit cycle jitter of +/- 15 arc minutes[1].

The primary instruments for the Princeton sounding rocket flights from 1964 through 1970 were Schmidt[2] cameras. These systems incorporate a full-aperture corrector for spherical mirrors. To facilitate UV spectrophotometry the correctors could be coated with layers of chemicals which enhanced the reflectance in the UV bands under study. Applying a coating of lithium-fluoride would enhance reflectance at wavelengths longer than 110 nm enabling study of Lyman alpha emission from the night sky. In a paper published in 1972 Dr. Morton describes the data processing from a June 1970 flight (4.271) as follows: "The Kodak far-ultraviolet film type 101-01 was used for all exposures. After the flight, the films were soaked in distilled water for 2 minutes and then developed at 68 deg F in D-19 for 6 minutes, except for the low resolution Scorpius exposure which was developed for only 4 minutes. The developing was monitored with a safe light and cut short on this one film which had a higher fog level as a result of either zero-order light from the horizon or zero- and first order Lyman alpha emission from the night sky. The intensity calibration was made by exposing strips of film for a range of times to a hydrogen lamp in a vacuum spectrograph and assuming reciprocity failure was absent."

Overall the UV astronomy program was a great success. Among other achievements the Princeton rocket spectrograph obtained the first UV spectra with enough resolution to show the line features in stars other than the Sun[3].

Today's sounding rocket scientists studying the Universe in the ultraviolet spectral range are following in the footsteps of Morton. An example of a current far-UV spectrograph is the Colorado High-resolution Echelle Stellar Spectrograph (CHESS), which gathers data in wavelengths between 102 and 160 nm. The Aerobee flight 4.267 had a slightly broader range 110 – 230 nm. Science targets for both payloads include stars in the Orion and Ophiuchus constellations. While science targets are the same much has changed in the capabilities of the program as well as the science instrumentation. The 4.267 payload is estimated to have weighed 300 lbs and reached an altitude of approximately 160 km**. The CHESS II payload weighs about 1,100 lbs and is predicted to fly to an altitude of 287 km. Pointing accuracy of the Star Tracker flying on CHESS is 0.5 arcseconds and Dr. France is not heading off to the darkroom to process film after the flight. CHESS has a state of the art micro-channel plate (MCP) detector, the echelle grating in CHESS uses an electron-beam lithography process to better control scatter, and a powered holographically-ruled cross disperser focuses the light onto a detector – things that probably would have been inconceivable in 1970. Where will sounding rockets be in another 45 years?

*The first sounding rocket was the WAC Corporal.

**Exact weight and altitude cannot be confirmed for 4.267 but Princeton flew the same instrument system several times and the estimated weight and altitude given here are from flights 4.052 and 4.271.

1) Blair D. Savage - Early ultraviolet spectroscopy from space

2) Developed by Estonian-born optician Bernhard Schmidt Its concept is based on the unique property of spherical mirror with the aperture stop at the center of curvature to be free from off-axis aberrations.

3) Sounding Rockets: Their Role in Space Research (1969)

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Want to contribute?

Working on something interesting, or have an idea for a story? Please let us know, we'd love to put it in print!

Contact:
Chuck Brodell
Phone: #1827
Email: Charles.L.Brodell@nasa.gov

or

Berit Bland
Phone: #2246
Email: Berit.H.Bland@nasa.gov

Launch Schedule

MISSION	DISCIPLINE	EXPERIMENTER	ORGANIZATION	PROJECT	RANGE	DATE	TIME
October							
36.310 GT	TEST & SUPPORT	HESH	GSFC-WFF		WI	6-Oct	DAY
46.011 GP	SPECIAL PROJECTS	MILLINER	NASA-WFF	MUSIC	WI	14-Oct	DAY
November							
36.293 UG	UV/OPTICAL ASTROPHYSICS	CHAKRABARTI	UNIV OF MASS - LOWELL	PICTURE	WS	15-Nov	NIGHT
52.002 UE	GEOSPACE SCIENCE	LESSARD	UNIV. OF NEW HAMPSHIRE	RENU 2	NOR	27-Nov	NIGHT
49.003 UE	GEOSPACE SCIENCE	LABELLE	DARTMOUTH COLLEGE	CAPER	NOR	27-Nov	NIGHT
12.083 CR	DOD/NESC	GILBERT	NESC	SPRINT	WS	24-Nov	DAY
December							
36.305 UH	HIGH ENERGY ASTROPHYSICS	GALEAZZI	UNIVERSITY OF MIAMI	DXL-2	WS	4-Dec	DAY
36.307 DS	SOLAR & HELIOSPHERIC	TUN BELTRAN	NAVAL RESEARCH LAB	HERSCHEL	WS	14-Dec	DAY
January							
36.312 UG	UV/OPTICAL ASTROPHYSICS	MCCANDLISS	JOHNS HOPKINS UNIV.	FORTIS	WS	7-Jan	NIGHT
February							
36.297 UG	UV/OPTICAL ASTROPHYSICS	FRANCE	UNIV. OF COLORADO	CHESS-2	WS	22-Feb	NIGHT

WS - White Sands
WI -Wallops Island
NOR - Norway

A total of 20 missions were flown in Fis–cal Year 2015. The six Geospace science missions spanned two continents with one launch from Norway and five from Alaska. Five solar and Heliospheric science missions were flown from White Sands Missile Range, NM as was the one High Energy Astophysics mission and three of the Reimbursable missions. One Reimburs–able mission was flown from Norway. The remaining flights, three Student Outreach missions and one Special Projects mission were flown from Wallops Island, VA.